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SCIENCE AND VALUES[1]

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A WISE custom recommends that this address be upon some topic in which substantial recent advances have been made and about which your retiring president is especially competent to speak. I have, nevertheless, chosen a topic about which very little has been learned in the past decade and in which I am not expert. The reason is that the topic is important for workers in all sciences, and is especially important now. You will all agree that wisdom in the wants and valuations which are the prime movers in human affairs has not kept up with knowledge of the brute facts of human nature, much less with knowledge of the lower animals, plants and inanimate nature. Foes of science are asserting, and some of its friends are admitting, that science is incompetent to improve the judgments of value and esteem which rule men. On the other hand, certain alert students of government, law and morals are suggesting that what is needed in the treatment of questions about good and bad, right and wrong, useful and harmful, is the matter-of-fact curiosity of science. So I invite your attention to some facts of the psychology of values, as I see them.

The facts about valuation have been much discussed under the title of "Ethics" and "Esthetics" by thinkers of philosophic temper. In spite of the great acuity and scope of their intellects, their efforts to devise general theories of the good or of the beautiful or of what men ought, and what they ought not, to enjoy have been unsatisfactory to philosophers as a whole, and rather mystifying or empty to men of science. Nor do they seem to profit by the general advancement of knowledge. Aristotle's solutions seem as good as

[1] Address of the retiring president of the American Association for the Advancement of Science, St. Louis, December 30, 1935.

Hegel's. Being extremely able men, they often propose ideas of great interest and influence, as do great poets and great theologians. But in cases where these ideas concern matters of observable fact, the observations and experiments of working scientists have often disproved their brilliant conjectures. To become a disciple of any of them in other matters is then risky. Their royal roads to knowing what is the right thing for each creature to do in each set of circumstances by learning what "The Good" is do not fulfil expectations.

Among the doctrines upon which they do show a high percentage of agreement is one which, though obviously true when taken advisedly, is likely to be a barrier to useful thought about valuation. That is the doctrine that the science (or super-science or meta-science) of ethics can be sharply distinguished from such natural sciences as biology, anthropology and psychology, since it is a normative science, telling what should be or must be, instead of describing what is and predicting what will be.

This doctrine is useful as a reminder that judgments that health, honesty and herrings are valuable differ from judgments that the Klebs-Loeffler bacillus causes diphtheria, that cheating in school children is negatively correlated with intelligence or that herring eggs will become herrings only under certain conditions. But it may do harm by encouraging us to argue and worry unprofitably about whether law, government and education can be sciences and what sort of sciences we should try to make them be. It may also frighten workers in the sciences of man away from observations of and experiments with values, and restrict them to studying only those parts of a man which he uses as materials and tools to satisfy his wants, neglecting the wants themselves.

Values vs. Mere Existence

Just what is the real and operative distinction between judgments of value or worth and judgments of fact or existence? Do the former concern categorical imperatives which are not amenable to the observations and experiments and predictions and verifications of the natural sciences? Must they be revealed by religion or deduced from some theory of a moral universe above or outside of the world of natural events?

My answer is that, on the contrary, judgments of value are simply one sort of judgments of fact, distinguished from the rest by two characteristics: They concern consequences. These are consequences to the wants of sentient beings. Values, positive and negative, reside in the satisfaction or annoyance felt by animals, persons or deities. If the occurrence of X can have no influence on the satisfaction or discomfort of anyone present or future, X has no value, is neither good nor bad, desirable nor undesirable. Values are functions of preferences. Judgments about values—statements that A is good, B is bad, C is right, D is useful—refer ultimately to satisfactions or annoyances in sentient creatures and depend upon their preferences. Competent students judge the existence of things by observations of them; they judge the values of things by observations of their consequences.

Values appear in the world when certain forms of preference appear, when certain animals like or dislike, enjoy or suffer, are contented or unhappy or feel pleasures or pains. They apparently precede learning and knowledge, which work chiefly in their service. Chicks or rats are indeed in a sense more confirmed moralists than civilized men. They pursue what is good, fit and proper to their minds with a wholehearted devotion. Their duty is often their pleasure also.

In civilized man the variety of the valued and disvalued increases greatly. There are many scales of merit, many points of view from which and in respect to which persons, acts, things, events, can be regarded as desirable or the reverse. One thing may have a score of different positive values and a dozen negative ones. The inborn values of sweet tastes, unimpeded movements, rest after exercise, exercise after rest, courtship and love, etc., are worked over into an enormous structure by the family, school, neighborhood, church, books, laws, and other man-made forces. Man acquires multifarious customs and traditions about values. Thus certain acts are good or right because they satisfy the tribal gods; others are so because they minister to the happiness of ancestors long since dead; others are right, one knows not why. Opinions about values become diverse and conflicting.

In assigning values on the basis of consequences, we may and do attach various weights to the consequences for ourselves, our friends, white men, black men and yellow men, sane, insane and idiotic men, dogs, horses, tigers and snakes, living men, the spirits of dead men and men yet to be, the God of our fathers and other gods, in case we recognize such at all. We also attach weight to remote and indirect consequences, for example, by way of the example set to others. There is also a large margin of guesswork, especially about what the consequences will be for the satisfaction of men of the distant future and men unlike ourselves. Opinions about consequences are also largely second-hand and conventional. The ratings by consequences are, however, always justified in the end by satisfactions or annoyances for some sentient being, if they are justified at all.

Alleged Absolute or Transcendental Values

We can choose whose satisfactions we shall give weight to and what sort of persons we shall esteem;

the two amount to essentially the same. But if sane and intelligent, we rarely attach value to something which makes no differences, directly or indirectly, to the satisfactions and annoyances of any sentient beings.

When certain moralists and theorists who are sane and highly intelligent give us the notion that they assert that certain qualities and acts can have an absolute intrinsic value, regardless of any satisfaction or annoyance to any sentient being, they or we (or both) are probably confused by analogies or verbal subtleties. It is to be observed that the qualities and acts alleged to be thus justified by their mere nature are easily justifiable as ministrants to real desires and aversions.

The commonest cases of alleged absolute values, irrespective of any satisfaction or annoyance to any sentient being, are truth, beauty and the development or perfection of human powers.

The truth, in the sense of those ideas about reality which correspond to it, enable us to predict it and lead us to adapt ourselves to it and to wants which are satisfiable by it, is a pure good. Anyone can possess it at no cost to anyone else and often to their enrichment; an increase in the amount of it available for men or in the amount of it possessed by an individual is, in and of itself, an aid in the satisfaction of other wants, and interferes with none of them. Whatever is an essential conflict with it is bad. Whether it has any more absolute warrant for commanding our regard we need not inquire, since even by the most empirical and utilitarian, or by the most metaphysical and supernaturalistic, theories it is valued as among the highest things a man may seek.

Beauty in the sense of that which causes unselfish, impersonal and noble enjoyment, free from exaltation of one at the expense of another's degradation, from use by one at the expense of another's deprivation, from taints of bestiality, meanness, stupidity, and the like, also ranks very high in any reasonable scheme of values. To make or to enjoy a poem that is fine satisfies good or at least innocent wants in the poet and his readers, without, in and of itself, reducing the satisfactions of any one else.

Creating and enjoying truth and beauty are samples of the class of satisfiers which involve positive satisfactions for some without subtraction from, and often with addition to, those of others. Enjoyment of the happiness of others is a third member of this class, and good health is a fourth. Other things being equal, such are obviously on the average better than what may be called the possessive or exclusive satisfiers, such as eating, ownership, supremacy or victory, where the satisfaction of one involves the deprivation of others. They are also samples of the dignified, as opposed to the trivial or mean satisfiers, such as chewing gum, scratching one's head or watching a dogfight. They have fine consequences and fine affiliations; and these are enough to guarantee them without assuming any absolute or transcendent quality in them.

The doctrine that the perfection of human powers furnishes a general criterion and rule for valuation was probably invented and maintained because of the belief that there must be some one adequate universal criterion, and the fact that to be perfect, to be the best of a certain sort or series is very often good. Since some powers, such as to deceive, defraud, terrify and torment, are obviously better restrained than developed, the limitation, harmonious, is often inserted. Powers whose perfecting is undesirable can then be excluded as being out of harmony with those which the theorist thinks are better.

There need be no one universal criterion, and the idea of perfecting is of little real value save as a suggestion that the good life of any creature depends upon what kind of creature he is. The addition of "harmonious" brings the practical applications of the doctrine back to a calculus of actual wants and satisfactions of sentient beings and their interrelations.

Values then reside in satisfactions and annoyances of sentient beings. In so far as these lie within the natural world of men and animals, they are amenable to scientific study. In so far as we think reasonably, not by prejudice, wishful delusion or chance, we judge the values of things, events and relations by their consequences. We also sometimes judge them indirectly by their affiliations. The theory and technique of estimating the value of a thing by its affiliations—by what it goes with—is important, but I lack time to explain, illustrate and justify it, and to show its proper uses, dangers and limitations. The value of any given fact to any given group is, in so far forth, a natural fact like the smell or taste of any given chemical to any given animal. Values are not banished entirely from the realm of science into some exalted sphere. Facts, principles and laws about values differ from facts, principles and laws about time, distance, area, volume, mass, temperature, chemical constitution, memory, dreams, knowledge, prices, diminishing returns, laws, customs, myths, taboos, family organization, etc., not fundamentally and utterly, but in the very important features which I have described.

They are amenable to the methods of science. But they are often much harder to determine, since they depend upon knowledge about sentient beings, present and future, their wants, the right weights to attach to each of these, and the consequences of the act or fact in question to each of them. As a result, there is a very wide variation in the common-sense knowledge

which science starts with and seeks to improve. The variation in the weights given, often unconsciously, is especially influential. In the actual genesis of moral judgments one of you may, and probably does, weight the satisfaction of himself and a dozen of his family and friends above those of all the worms in the world; but some St. Francis or Brahmin may not. The saint may weight the satisfactions of any other Christian as equal to his own, but the average sensual man does not. The abstract thinker may give substantial weight to the satisfactions of the human species in 3000 A.D., but these vanish in the valuations of most men. Such habits and attitudes acquired and used in ordinary life are hard to exclude when one tries to judge impartially as if he were a trustee for the welfare of the world or a purely scientific solver of the world's problems.

The Assignment of Weights

Assuming that all human beings, present and future, are to be considered, how should an impartial student, a trustee for the welfare of all, assign weights? His criterion will be, as always, the consequences.

If the satisfaction of a certain want (say for food, or for power, or for approval) in A bids fair to cause great benefit to all men, whereas the satisfaction of the same want in B bids fair to cause little, he will weight A's want much more heavily than B's.

When it is not feasible to learn what the consequences of weighting one person's satisfactions more than another's will be, our trustee for humanity will do well to weight the wants of good men more than the same wants of bad men, since there is a probability that the gratification of wants will cause both to maintain or increase their customary activities.

Goodness and intelligence are positively correlated: so he will for the same reason do well to weight the wants of intelligent men more than the same wants of dull men.

He will do well to weight the wants of the men of 1950 above the same wants in the men of 2050, unless he has reason to suppose that the latter will be better men than the former, for there may be no men in 2050, and if there are, they may, some or all, lack the want in question. He will, however, give far more weight to the men of 2050 and 2150 than statesmen do or than most philanthropists have ever done.

Ethics, politics and philanthropy have been guilty of neglecting individual differences, partly because doing so simplifies all problems, and partly because of the retention of theological and sentimental prejudices in favor of the similarity and equality of man.

No egalitarian system of weights can be just or wise. More weight should be given to the wants of superior men than to the wants of inferior men. What able and good men want is much more likely to be better for their community or nation or race or the world as a whole than what stupid and bad men want. Providing for their wants will presumably enable them to do more of what they want to do; and this will improve the world and its customs for future residents. Other things being equal, it should lead them to have more offspring, and this will improve the world by increasing its percentage of good men.

It is of special importance to attach great weight to the wants of those individuals who have eminent abilities in the impersonal activities of art, science and the management of men. What such persons want will be largely time and freedom to do their work in, tools to do it with and conditions enabling them to do their best. They will doubtless sometimes want what is not good for their work for the world; but their judgment will on the whole be a good guide when knowledge of consequences is lacking.

It seems probable that the harmful vagaries of men of genius in the fine arts would have been much reduced if their cravings for untrammeled expression in art itself and for approval of their real merits had been more fully satisfied. It also seems at least possible that the ruthlessness and selfishness of some men of genius in business and government would have been reduced if they had been given power more and been less required to extort it by force. Even if these creators continue to seek occasionally eccentric, ignoble or ruthless satisfactions, it will still be an excellent bargain for the world to attach great weight to their wants as a whole. The world's greatest folly has been its treatment of those who are most superior to it in intellect, originality, sensitiveness and humaneness. Its most prudent investment is to find them out early, and give them whatever they need to do their perfect work. One good clue to what they need is what they themselves desire.

Human Wants

The work of a science of values, a realistic ethics, is to learn what men do want and how to improve their wants, and to trace the consequences of acts, events, ideas, attitudes, etc.

What are the fundamental and dependable satisfactions of life for man? A leading psychiatrist answers, "Love and security." But a student of boy's gangs may think that "Conflict and adventure" is as good an answer. The philanthropists of the early and mid nineteenth century thought that men would be satisfied if they and their children were without hunger and pain, able to read, with regular work ten hours a day and freedom to think and vote as they liked. Cynics of the twentieth century doubt whether people in general really want liberty and culture as much as beer and excitement.

I have no satisfactory answer, and no time to state the provisional answer which anthropology, psychology, sociology and the other sciences of man suggest. I shall instead report one small bit of evidence concerning what the inhabitants of this country want.

We do know fairly well how the population of this country spent their incomes in 1929. Using the figures given by Lynd and supplemented by Dr. Ella Woodyard, we have 17 billions for food, 8 billions for clothing, 6½ billions for automobiles, and so on through thirty items like a billion and a half for laundry, cleaning and dyeing, over a billion and a half for tobacco, to three quarters of a billion for death and burial.

The payment for food satisfies chiefly hunger, appetite and the want for sweet and savory tastes, but also in part the craving for social enjoyments, for the approval and esteem of others, for protection against disease. Payment for physicians is chiefly for protection against disease and pain, but also helps to satisfy the more general cravings for security, comfort, self-respect and the approval of others. Laundry bills represent the satisfactions of self-respect and social approval, protection against disease, pleasures of sight and smell, and others also.

By the aid of a consensus of psychologists, I have divided each item of our people's expenses among the wants to which it probably ministers, and then combined the results into a list of wants and the amounts paid for the satisfaction thereof. The outcome will suffer from whatever constant errors afflict psychologists to-day, but this inventory of wants satisfied from income is at least a step in the right direction. I shall not present it in detail, but only by samples. According to it:

Our bill for food is spent as follows: 56 per cent. to satisfy hunger; 15 per cent. to gratify the pleasures of taste and smell; 10 per cent. for the pleasures of companionship and social intercourse, including courtship; 3½ per cent. for the approval of others, and smaller percentages for protection against disease, protection against cold, enjoyment of the comfort of others and the pleasures of vision.

Our bill for clothes is spent (according to the psychologist's distribution): 41 per cent. for protection against cold, heat and wet; 6¾ per cent. for protection against animals and disease; 12½ per cent. for the approval of others; 7 per cent. for self-approval; 10 per cent. to gain pleasure in courtship and sex activities; 8 per cent. for other social intercourse; 6 per cent. for pleasures of vision; 3½ per cent. to win mastery or domination over others, and 2 per cent. to win their affection.

The 700 million dollars for cosmetics and beauty parlors is spent about one seventh for the pleasures of sight and smell, one fourth for the pleasures of sex and courtship, one third to gain general approval from others, one eighth to have inner-self-approval, and about one tenth to secure mastery or domination.

When the entire annual budget is thus transformed item by item into a budget for the satisfaction of human wants, payments for sensory pleasures, security, approval of others and the pleasures of companionship and sociability (including romance and courtship) are in each case close in magnitude to the amount paid for freedom from hunger. In fact, we pay more to maintain self-respect and the good opinion of others and avoid scorn, derision and shame than to keep our bodies fed and free from the distress of hunger.

We pay more for entertainment (including the intellectual pleasures and the sensory pleasures of sight, sound, taste and smell) than for protection against cold, heat, wet, animals, disease, criminals and other bad people, and pain.

Less than one third of what we spent went for wants which must be satisfied to keep the human species alive and self-perpetuating. The rest went chiefly to keep us amused and comfortable physically, intellectually, morally and especially socially.

Relatively little is paid for the satisfactions of the intellectual life. The psychologists consider that the payments for private schools, books and magazines are often for prestige, power and other practical satisfactions, and do not credit the theaters and movies of 1929 with much intellectual appeal.

The psychologists do, however, pay us the compliment of crediting us with spending twice as much from good will to man as from fear of criminals and other bad men, and of spending at least as much to win the affection of our fellow men as to have the pleasure of bossing them.

In tracing the consequences of ideas, acts, laws, customs, inventions, etc., both the biological and the social sciences have somewhat neglected the inner or mental wants of men. Nourishing food, hygienic housing, medical care, relief from bodily pain and fatigue have, quite naturally, been emphasized. But inner peace, contentment, a sense of personal worth, surety of friendship and affection, the absence of fear, the presence of a good conscience and other states of mind are also real and important.

Many features in religions, caste systems and other folkways which seem undesirable to us did have the merit of satisfying some of these deep inner needs. If we abandon such folkways on the ground that they are deceptive and unjust, we should replace them by something true and just which gives equal comfort, dignity and flavor to the inner lives of men. Doubtless it is better to be a dissatisfied Socrates than a satisfied pig; but also it is worse to be a dissatisfied coolie than a satisfied coolie. Most discontent is not divine. Not once in ten thousand times will becoming dissatisfied cause a coolie to become a Socrates. Some inner con-

flicts, miseries and rebellions are good, if not for the man's soul, at least for his work for the world. But many are not good for anything.

Theoretically, men should face the facts of the world, including all their own weaknesses and follies, make a reasonable adjustment and then live serene in the faith that they are doing their best and that all the good in all the world should and will support them so far as it can. But how can they be taught to do this?

The Improvement of Wants

The desires and aversions of men can be changed as truly as their ideas and habits, though not as much or as easily. The same forces of repetition and reward that strengthen tendencies to think and act operate upon tendencies to like and dislike. If a certain attitude can be made to occur in a person in connection with a certain situation, and if he is led to regard it as fit and proper in that connection, he will "learn" to take that attitude to that situation just as he learns to think "ten" in response to "seven plus three." In strengthening good wants and in attaching desire to good objects, there are, however, difficulties and limitations which are absent in the more neutral unprejudiced sphere of ideas and skills. Experiments in changing wants, interests and attitudes do not justify the fond hopes of certain doctrinaires in sociology and education, but they do guarantee that, if sound methods are used, men can be taught to find satisfaction in useful work, healthful and noble recreation and the welfare of others, to a degree that the world has never seen.

What is known concerning the inheritance of moral traits in man and the lower animals encourages us to hope that the inborn cravings of men may be improved at no cost to other goods.

Tracing Consequences

The consequences of events, especially of the ideas and acts of men, to the satisfactions of mankind, need study by all the sciences of man and nature.

Non-scientific estimates are sadly untrustworthy. The national prohibition of the sale of alcoholic liquors did not have the consequences which millions of people expected who worked to attain it. Who knows what its consequences would have been if the work that attained it had been quadrupled to secure its enforcement? Among all the consequences, beneficial and ruinous, blessed and dire, which were expected from the granting of votes to women, which were real? People accept guesses and follow the unconscious logic of hope and fear in estimating consequences, perhaps because they feel that good intentions are the important requirements.

People also naively expect that everything will stay the same except what is changed by direct action upon it. Nine persons out of ten, and possibly ninety-nine out of a hundred, assume that the general features of civilization which are stable in their experience will remain so. Roads, schools, policemen, houses, beds, payment for work, a chance to buy what you want if you have the purchase price and a hundred other commonplaces of our social order will continue like the sunshine or rain. So they think.

To think anything else is almost a psychological impossibility for the ordinary man of this country today. He does not realize that these features of his life depend upon an extremely complex structure of ideas and acts of rulers and ruled, employers and employed, parents and children, borrowers and lenders, and are kept in condition by an equally complex structure of customs and laws. He has no more fear that any act of his or anybody else will stop railroad trains from running than that it will stop the sun from shining. Laying a tax on incomes is to him like digging a ditch that diverts the rain from one place to another. He does not have the slightest fear that it will have any effect on the amount of income. Why should he? To do so he must reason, and reason against habit and experience. Only exceptional minds do that.

Scientific ethics must rely largely on economics, political science, sociology, psychology, education and biology in studying the values positive and negative of all sorts of activities; for example, paying prisoners full wages for their work, keeping criminals under surveillance by parole officers instead of incarcerating them, legalizing divorce when both parties desire it, encouraging birth control by the weakly, dull and psychopathic, taking property by force from the rich and giving it to the poor, trying to make one's own community or nation wax rich and strong at the expense of others by tariffs and quotas, and other moral or semi-moral issues, where action is now unfortunately being taken largely as a result of the emotional interests of enthusiasts or the selfish interests of special groups.

This lays a heavy burden upon these sciences, and cautious workers will be reluctant to take it on. Questions about consequences to human welfare are often confused by conventional interpretations of welfare; one is tempted away from fundamental inquiries which are really important to superficial questions which seem important to the public; the basic facts are often lacking; devising ways and means to secure trustworthy observations is very difficult; even after heroic labors, the solution may have a disgustingly wide margin of error.

So science has been rather willing to leave values alone. So psychologists rarely study the causes of happiness, economists recoil from all wants save those expressed in money prices, students of education deal with the consequences of school work upon abilities,

but not, save rarely, upon desires and satisfactions. So we all have left and still tend to leave decision about consequences to humanists—to philosophers, sages, men of affairs, historians and literary men.

Some of the humanists would gladly accept the responsibility, being confident that science should leave such decisions to them. They distrust the activities of the social sciences and especially their entry into the field of human values. It is better, such a humanist will assert, to listen to the seers and sages and to follow the dreams of inspired artists and moralists than to poke about in the schools, streets, market-places, prisons and asylums, or collect statistics, or drag human aspirations into the laboratory.

We may reasonably think that it is better to do both. We should admit that Thucidydes reports a better description of liberty than the average Ph.D. candidate in political science to-day would give. If we had to choose between reading Sophocles and Euripides and reading the most scientific family budgets, we would reject the science. We would have science gladly learn and gladly teach what able men have thought about the consequences of various forms of conduct, but we would also have it test and experiment, regarding nothing as outside the scope of science.

Much of the scorn of certain humanists for the efforts of modern science seems to be due to the fact that the observations and experiments of scientific workers make dull reading. A cardinal virtue of these humanists is to be interesting; many of them are literary men to whom success in entertaining cultivated persons is a duty, as well as a source of pleasure and pride. It is partly because of this that we can not trust the humanist alone. We must be suspicious of interest as a guide in any tracing of consequences. The talent for selecting what has a literary appeal may well be wrapped tight in a napkin and buried deep while one is doing scientific research.

We must consider one final objection to using the methods of science in the world of values. Science, according to a very popular view, deals with a fatalistic world in which men, their wants and ideals, are all parts of a reel which unwinds year by year, minor whirls in a fixed dance of atoms. Values can have no place in such a world, and efforts to attain them by science must fail.

The truth of the matter, which is rather subtle, may best be realized by considering what I have elsewhere called the paradox of science, which is that scientists discover "causal" sequences and describe the world as one where the same cause will always produce the same effect, in order to change that world into a form nearer their heart's desire. Man makes the world a better home for man and himself a more successful dweller in it by discovering its regular unchangeable modes of action. He can determine the fate of the world and his own best, not by prayers or threats, but by treating it and himself by the method of science as phenomena, determined, as far as he can see, by their past history. The only safe way he finds to gratify human wants and fulfil human aspirations is by learning the regular predictable modes of action of nature, especially those which relate to these wants and aspirations. The more fully he can turn the world into a progression of events devoid of chance, unswerved from its onward march by any magic, the more he can control it. If man should know himself as fully as he knows the chemicals he puts into a test-tube, so that he could predict the exact reaction he would make to any situation, he would be better able to control and improve his own future than any race of men or gods has ever been.

A deterministic world of science is the least fatalistic world there can be. A world entirely ruled by the wishes of deities external to it would be utterly fatalistic. It would present a far more hopeless determinism than the determinism of science, for human access to and influence upon those forces external to nature would be difficult and of doubtful avail, whereas the nature we live in and are parts of we may hope to influence.

The solution of the paradox lies in this last fact. Men are parts of nature. They and the scientific knowledge they acquire and the choices they make are on the reel, in the dance of atoms, among the marching events. Their wants and aspirations can determine nature's future because they are determined by nature's past. Everything that man is and does influences nature. Any ideas men have influence it. The knowledge of it as a complex of the regular "determined" sequences described in the so-called "laws" of science is the force that man can use most advantageously in changing men and the rest of nature to fit human wants. If and as the world is determined, there is hope of controlling it in the interest of human values. Every regularity or law that science can discover in the consequences of events will be a step toward the only freedom that is of the slightest use to man, and an aid in the good life. If values did not reside in the orderly world of nature, but depended on chance and caprice, it would be vain to try to increase them.

Are there any valid reasons why the methods of science should be abandoned in favor of either philosophical arguments or intuitional conclusions when one passes from facts of existence to facts of value? We have found none. It is certainly undesirable for men of science to restrict their thinking to what is and will be, leaving to propagandists and reformers and talkers the decisions about what ought to be. Is any group of thinkers qualified to study the wants of mankind, the consequences of acts and events, and the

improvement of human valuations without reliance on the facts and methods of anthropology, psychology, sociology, economics, government and other sciences of man? Can science avoid the responsibility of trying what impartial curiosity and honest work can accomplish in this field of controversy and prejudice?

The world needs the insights and valuations of great sages and dreamers. It needs the practical psychology of men of affairs, leaders in business, government and education. But it also needs scientific methods to test the worth of the prophets' dreams, and scientific humanists to inform and advise its men of affairs and to advise them not only about what is, but about what is right and good.

OBITUARY

THOMAS LEROY HANKINSON

ONE more member was lost to the decreasing tribe of real naturalists on December 3, 1935, when Thomas Leroy Hankinson died at Ypsilanti, Michigan, following a week of acute illness. Throughout his last several years of declining health, Professor Hankinson maintained the intense interest and enthusiasm which marked all his long career as teacher and researcher. A considerable number of biologists owe their initial inspiration and training to this man.

Born on April 12, 1876, at Valparaiso, Indiana, Thomas Hankinson was bereaved of his parents at an early age, whereupon he passed to the care of an uncle who lived at Hillsdale, Michigan. In this lake region the lad gained his unceasing interest in fish and bird life and natural history in general. He graduated from Michigan State College in 1898 and from Cornell University in 1900, and continued his studies in the latter institution for two years. From 1902 to 1919 he taught in Eastern Illinois Normal College; from 1919 to 1921 he served as ichthyologist of the Roosevelt Wild Life Experiment Station of the New York State College of Forestry; from 1921 until his death, he was professor of zoology at Michigan State Normal College; recently he acted also as research associate in the Museum of Zoology, University of Michigan. He served summers on natural history surveys or in conservation work for the states of Michigan, Ohio, Illinois, North Dakota and New York. He was a member of numerous scientific societies and served as president of the Wilson Club, as treasurer of the American Society of Ichthyologists and Herpetologists, as treasurer and vice-president of the American Microscopical Society, as treasurer of the Illinois Academy of Science and as vice-president of the Ecological Society of America.

Professor Hankinson was the author of numerous works on the ecology, life history, conservation and systematics of the animals of the several North Central states, particularly of fishes. He has left an even larger amount of unpublished data, including a large general work on the ecology of the Cyprinidae of the Great Lakes region. Much of the results of his work has been contributed to the researches and publications of his colleagues.

Professor Hankinson's life has been one of continuous service to his science and to his fellow scientists. May his tribe increase.

CARL L. HUBBS

RECENT DEATHS

DR. WILLIAM ELWOOD BYERLY, who retired with the title emeritus in 1913 from the Perkins professorship of mathematics at Harvard University, died on December 20 at the age of eighty-six years.

WILLIAM CARROLL LATTA, professor emeritus of agriculture at Purdue University, died on December 22. He was eighty-five years old.

DR. HOWELL T. PERSHING, professor of neurology and psychiatry in the University of Colorado, practising physician in Denver, died on November 30 at the age of seventy-seven years.

ALEXANDER MACDONALD, formerly New York State conservation commissioner, died on December 20.

DR. WILLIAM COLLIER, who was president of the British Medical Association in 1904, died on December 22 at the age of seventy-nine years.

PROFESSOR VICTOR GRIGNARD, of the faculty of science at the University of Lyons, died on December 13 at the age of sixty-four years. M. Grignard received the Nobel prize for chemistry in 1912.

SCIENTIFIC EVENTS

THE UNIVERSITY OF CAMBRIDGE AND DR. KAPITZA

THE University of Cambridge learned in April that Dr. Peter Kapitza, fellow of Trinity College and director of the Royal Society Mond Laboratory, was not returning from Russia to continue his researches with intense magnetic fields, for which special equipment had been provided. During the summer, according to a summary of the negotiations presented in the London *Times*, proposals were received from Russia

for the purchase of this equipment for re-erection in the USSR and the council of the senate at the University of Cambridge has now reported to the university on the proposed sale of apparatus from the Royal Society Mond Laboratory.

In its report, after describing the apparatus, the committee stated that some of the apparatus in the laboratory is of little use to the present program of work and could be transferred immediately to Russia; the remainder of the apparatus is required for the general development of low temperature work, which is now actively progressing. It would, however, be possible to supply duplicates of most of this apparatus within a year without serious interference with the work of the laboratory. One of the requests made by Dr. Kapitza was that he should obtain the services of two of the laboratory assistants for a period of about three years. These assistants have been consulted, and while they may be willing to go to Russia if the committee consents and for a limited period, to assist Dr. Kapitza in re-erecting his apparatus, they are not willing to settle there permanently.

The committee points out that while it is anxious to help Dr. Kapitza to continue in Russia the work which he was undertaking so successfully in England, the work of the laboratory must be carried on and developed, and the wishes of Dr. Kapitza could only be met in so far as they did not interfere with the program of work now being undertaken at Cambridge.

The committee, on the understanding that Dr. Kapitza will have the use of the apparatus so long as he wishes, accordingly submitted for the consideration of the council of the senate the following recommendation:

(1) The university should offer to buy from the government the apparatus in the laboratory which was supplied prior to April, 1926.

(2) The university should transfer to the Government of the USSR the generator and all auxiliary apparatus required for the production of intense magnetic fields and for the study of their effects.

(3) The university should supply duplicates of the remainder of the apparatus in the laboratory, including the helium and hydrogen liquefaction plants, to the Government of the USSR.

(4) That the Government of the USSR should pay to the university a sum to be agreed upon by the Financial Board.

These were later approved by the council, by the Royal Society, by the Department of Scientific and Industrial Research and by the government of the USSR. Members of the committee signing the report were: Rutherford, F. W. Aston, T. Knox-Shaw, C. T. R. Wilson, H. Thirkill, Rayleigh, F. S. Smith.

BUDGET OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

THE Massachusetts Institute of Technology ended its fiscal year with a balanced operating budget, according to the annual report of its treasurer, Horace S. Ford.

Although the past year's budget appropriations called for an expenditure of $65,000 in excess of income estimates and student income was reduced by $48,000, increased income from investments to the amount of $61,000 with other available resources made it possible to balance the budget of $2,695,000 with a modest margin.

The academic expenses of the year increased $60,000, administration expenses rose $6,000, while plant expenses, due to building operations, were up $4,000. Miscellaneous expenses, however, decreased $22,000, with a resulting total net increase of $48,000. The cumulative deficit on account of operations since 1865 now stands at $24,951, a reduction of $4,927 from the previous year.

The treasurer's balance sheet shows that the endowment funds now amount to $31,767,649, a decrease of approximately $81,000 over the previous year—this, in spite of capital gifts and additions of $484,558—a marked upward turn over the past few years. Of this, $257,000 was received by the institute in the distribution under the Edwin A. Wyeth Trust.

The market value of all securities held on June 29, 1935, was 102.5 per cent. of their book value with corresponding figures of 93 per cent. in 1934, 82 per cent. in 1933 and 66 per cent. in 1932. The net yield of all funds for the year was 4.65 per cent. This compares with 4.53 per cent. a year ago, 4.47 per cent. in 1933 and 4.54 per cent. in 1932.

Charles Hayden, in his report as chairman of the Technology Loan Fund Committee, shows total subscriptions for five years, $1,161,720; income for period, $115,751; profit on securities sold, $22,874; total $1,300,345. The amount remitted to the institute for loans to students over the five-year period is $675,700, leaving a balance in the hands of the committee of $624,645.

On the loan account, the notes receivable now stand at $719,600 as compared with $629,150 a year ago. That the loan fund has really begun to revolve is evidenced by repayments on principal made by students during the year, $69,476, as contrasted with $43,264 the year before. Interest payments amounted to $14,651 against $9,688 in 1934.

The report of the trustee of the Pension Association shows continued growth. Funds in the hands of the trustees now amount to $928,194 against $821,513 a year ago. The market value of the securities

showed a market value of $932,760 on a book value of $898,433. There are now twenty-three former members of the staff who are receiving pensions under the various plans offered.

REPORT OF THE RETIRING DIRECTOR OF THE U. S. BIOLOGICAL SURVEY

THE report of J. N. Darling, retiring chief of the U. S. Biological Survey, recently made public, gives a full account of the work of the survey.

Research work during the year included an intensified investigation of waterfowl conditions, studies of elk, mountain sheep and of caribou in Minnesota; and research in forest wildlife relationships. Statistics showed that 249,829 birds were banded by cooperators during the year; 113 mammal specimens were added to the survey collection, and 662 bird specimens were acquired, chiefly from North Carolina, Georgia and Virginia.

Mr. Darling points out that the survey has developed and published the facts regarding the economic, recreational and esthetic values and the requirements of wildlife and has built up a public sentiment that has made possible the necessary but heretofore unheard-of restrictions on hunting.

The report cites the acquisition and administration of a rapidly increasing number of bird refuges and big-game preserves. The survey has also furnished to agriculture, horticulture, stock raising and forestry a service worth millions of dollars annually, by demonstrating and cooperating in the control of predatory animals and destructive rodents. The numbers of injurious rodents were reduced on 11,166,935 acres for the protection of crops.

Plans for a program of wildlife research, demonstration and education, through cooperation with selected land-grant colleges and state game commissions, were completed and cooperative studies on national forests were extended; the Wichita National Forest and Game Preserve (Okla.) was transferred to the Biological Survey for administration as a wildlife refuge and research station; the importance of the country's fur resource was emphasized in land-management policies and research on suitable species was broadened; all outstanding scientific collecting permits for migratory birds were revoked and new ones issued only on an annual basis to insure against misuse.

Allotments from emergency funds during the year provided "the most noteworthy contribution the federal government has ever made to wild-life." The larger part of a million-dollar fund for acquiring refuge lands was obligated; about $2,100,000 of a two and one half million dollar fund for rehabilitation of new and old refuge areas was either expended or obligated, and in addition nearly all of a fund of $5,000,000 earmarked by the Federal Emergency Relief Administration for the purchase of migratory-waterfowl refuge areas. The Biological Survey thus obtained a group of the most outstanding waterfowl-refuge areas in the country.

BROADCASTS FROM THE CALIFORNIA INSTITUTE OF TECHNOLOGY

BROADCASTS by the Columbia Broadcasting Company on "Recent Scientific Progress" have been arranged at the Athenaeum in Pasadena under the auspices of the California Institute Associates. The series opened on December 14, and will be continued during the months of January, February, March and April, 1936. The second lecture will be given on January 4, and the remaining lectures will follow at intervals. The program follows:

Physics—Dr. Robert A. Millikan, Nobel Laureate, director of the Norman Bridge Laboratory of Physics.
Geology—Dr. John P. Buwalda, professor of geology.
Astronomy—Dr. Walter S. Adams, director, Mount Wilson Observatory of the Carnegie Institution of Washington.
Mathematics—Dr. Eric T. Bell, professor of mathematics.
Biology—Dr. Thomas Hunt Morgan, Nobel Laureate, chairman of the Division of Biology, William G. Kerckhoff Laboratories of the Biological Sciences.
Engineering and Aeronautics—Dr. Theodor von Kármán, director of the Daniel Guggenheim Aeronautical Laboratory, and Dr. Clark B. Millikan, associate professor of aeronautics.
Cosmology—Dr. Richard Chace Tolman, professor of physical chemistry and mathematical physics and dean of the Graduate School.

SCIENTIFIC NOTES AND NEWS

DR. W. C. MENDENHALL, director of the United States Geological Survey, was elected president of the Geological Society of America at the annual meeting held in New York City on November 26, 27 and 28. He succeeds Dr. Nevin M. Fenneman, professor of geology and geography at the University of Cincinnati.

DR. THOMAS M. RIVERS, member of the Rockefeller Institute for Medical Research, was elected president of the American Society of Bacteriologists, at the recent New York City meeting. He succeeds Dr. Karl F. Meyer, director of the Hooper Foundation, who is now ill as the result of an infection incurred during his work on psittacosis.

THE Warren Triennial Prize of $500 has been awarded by the general executive committee of the

Massachusetts General Hospital, Boston, to Dr. Norman E. Freeman, a member of the staff, for an essay on "The Physiology of Gangrene." The prize was founded by the late J. Mason Warren in memory of his father and is awarded every three years.

THE *Journal* of the American Medical Association states that members of the staffs of the University of Pennsylvania, Graduate, Presbyterian and Abington Memorial hospitals gave a testimonial dinner on November 16, in honor of Dr. George M. Coates, professor of otolaryngology, University of Pennsylvania School of Medicine. A feature of the dinner was the presentation to Dr. Coates of a portrait to be hung in the School of Medicine. Dr. Benjamin H. Shuster made the presentation.

AT the recent annual meeting of the American Society for Metals, Zay Jeffries, consulting metallurgist of the Aluminum Company of America, received the Albert Sauveur Medal, awarded for outstanding contributions to metallurgical progress.

THE A. Cressy Morrison Prize of $250 for the best scientific paper presented by a member of the New York Academy of Sciences, or of one of the affiliated societies, on a subject comprised within the field of these various organizations, was awarded at the annual meeting of the academy on December 16 to Arthur David Howard, of New York University, for his paper entitled "Pleistocene History of the Grand Canyon of the Yellowstone."

THE University of Oxford has conferred the title of "professor" on Dr. Henry Balfour, since 1891 curator of the Pitt-Rivers Museum.

DR. F. O. BOWER, emeritus professor of botany in the University of Glasgow, has been elected a corresponding member of the Prussian Academy of Sciences.

THE Lorentz Medal of the Royal Academy of Sciences at Amsterdam has been awarded to Dr. Peter Debye, professor of physics at the University of Leipzig.

PROFESSOR GUSTAVE ROUSSY, dean of the Faculty of Medicine of the University of Paris and director of the anti-cancer center of the Paris region, has been made a commander in the Legion of Honor.

Nature writes: "At the meeting of the Geological Society of London on November 20, Professor C. P. Berkey and Professor P. D. Quensel were elected foreign members, and Professor F. Broili and Dr. E. P. de Oliveira foreign correspondents. Professor Charles P. Berkey, of Columbia University, is the secretary of the Geological Society of America. His publications cover a wide field, but in recent years have been principally devoted to the geology of Mongolia. Professor Percy Quensel, of the University of Stockholm, is known for the elucidation of the problems of the petrology and structural features of the older rocks. Professor Ferdinand Broili, of the University at Munich, is known for his studies of fossil reptiles, brachiopods and trilobites. Dr. Euzebio Paulo de Oliveira is the director of the Geological Survey of Brazil.

R. S. ARCHER, chief metallurgist of the Chicago District, Republic Steel Corporation, was elected president of the American Society for Metals at the recent annual meeting. E. C. Bain, assistant to the vice-president of the United States Steel Corporation, was elected vice-president.

Nature reports that Professor W. H. Hoffmann, of the Finlay Institute of Havana, has been elected president of the recently founded Cuban Society of Biology.

PROFESSOR ACHARD has been reelected permanent secretary of the Academy of Medicine of Paris.

THE following officers of the New York City Branch of the Society of American Bacteriologists have been elected for the year 1936: Dr. Theodore Curphey, St. John's Hospital, *chairman;* Dr. Morton C. Kahn, Cornell Medical College, *vice-chairman,* and Dr. William W. Browne, College of the City of New York, *secretary-treasurer.*

DR. RALPH H. HEEREN has been appointed associate professor of hygiene, preventive medicine and bacteriology at the State University of Iowa College of Medicine, Iowa City.

DR. ERNEST RENAUX has been appointed the successor to Professor Jules Bordet in the chair of bacteriology in the University of Brussels.

DR. WILLIAM HALLOCK PARK retired on his seventy-second birthday anniversary on December 30 from active work as director of the Bureau of Laboratories of the New York Department of Health. He will take a six months' vacation, after which he will retire permanently as director and become director emeritus. He has held the post for forty-one years. The new William H. Park Research Laboratories, named in his honor, will have been completed, so that they can be dedicated while Dr. Park is still nominally in the city's service. He expects to continue to work at the laboratories in an advisory capacity. Dr. Ralph Muckenfuss, acting associate director, will be in charge during his absence. Next summer Dr. Park will retire from the Hermann M. Biggs professorship of preventive medicine at the New York University College of Medicine.

DR. ISAAC MONROE CLINE, principal meteorologist of the U. S. Weather Bureau in New Orleans, retired at

the end of the year, after serving for over fifty-three years. It is reported that Willard F. McDonald, formerly administrative assistant to Dr. Cline, who went to Washington as head of the marine division of the Weather Bureau in 1931, is expected to succeed Dr. Cline, with the title of administrator, and R. A. Dyke, senior meteorologist in the bureau in New Orleans, is expected to become chief forecaster.

DR. JOHN S. UNGER, long associated with the Carnegie Steel Company and since 1908 manager of the Central Research Bureau, recently resigned his position just prior to his eightieth birthday. According to the *Bulletin* of the society he has been a member for over twenty-five years of the American Society for Testing Materials and has served on a number of standing committees.

Museum News reports that new appointments for 1935–36 in the American Association of Zoological Parks and Aquariums include the following chairmen of standing committees: membership, Roger Conant, curator of reptiles, Philadelphia Zoological Garden; statistics and publications, W. Reid Blair, director, New York Zoological Park; legislation, Mrs. Belle J. Benchley, executive secretary, Zoological Society of San Diego; express and transportation, Robert A. Bean, assistant director, Chicago Zoological Park, and design and construction, John E. Wallace, architect, St. Louis Zoological Park.

BEGINNING with the issue of January 1, Dr. Herbert S. Gasser will become co-editor of *The Journal of Experimental Medicine* with Dr. Simon Flexner and Dr. Peyton Rous.

DR. LOUIS C. KRESS, director of the New York State Division of Cancer Control, has been appointed chairman of the state cancer committee of the American Society for the Control of Cancer, succeeding Dr. Burton T. Simpson.

DR. T. E. ODLAND, of Rhode Island, and Dr. H. P. Cooper, of South Carolina, have been appointed representatives of the American Society of Agronomy on the Council of the American Association for the Advancement of Science for the year 1936.

THE Committee on Scientific Research of the American Medical Association has made a grant to Dr. Jessie L. King, of the department of physiology and hygiene at Goucher College, Baltimore, in aid of research on the effect of cortical extract on normal rats.

F. TRUBEE DAVISON, president of the American Museum of Natural History, sailed with Mrs. Davison on December 28 on the first lap of a journey to India. They intend to do some hunting and will probably collect flora and fauna for the museum, though that will be incidental to the trip. They expect to return in April.

DR. S. C. BROOKS, professor of zoology at the University of California and Dr. Matilda M. Brooks, research associate in biology, will be on leave from January to June, 1936. They will spend the first part of the winter in Tahiti, experimenting on Valonia.

THE sum of a million and a half dollars has been added to the gift recently made by the Horace H. Rackham and Mary A. Rackham Fund to the University of Michigan. This additional benefaction brings the total amount of the grants for the furtherance of advanced study and research by this fund to the university to $6,500,000. With the possible exception of the gifts of the late William W. Cook, this is the largest gift ever received by the university.

A GIFT of $2,000,000 from Lucius N. Littauer, of New York City, manufacturer and ex-congressman, has been made to Harvard University for the establishment of a Graduate School of Public Administration. Half a million dollars has already been received and the balance will be received within the next two years. A "commission," of which President Harold W. Dodds, of Princeton University, will be chairman, has been appointed to make a comprehensive report on university education for public service and to recommend plans for the organization of the new school.

A GIFT of $500,000 to Harvard University from Thomas W. Lamont, of New York, for the founding of one of the new university professorships under Harvard's three hundredth anniversary fund plan, has been announced. The purpose of the anniversary fund, as described by President Conant, is "to strengthen the university as a national institution" by establishing pioneering interdepartmental professorships of an entirely new type and by creating large annual national prize scholarships to be competed for by boys in each state of the union. The gift is without restriction, under the general purposes of the three hundredth anniversary fund, but it is suggested that the professorship might be used for the first time in the field of political economy. This is the first gift of a professorship under the new plan.

BY the will of Charles Howard Warren, formerly treasurer of the Mutual Life Insurance Company, his residuary estate, estimated at $1,000,000, is bequeathed to Yale University. The bequest is to aid young men in securing educational advantages and as a "memorial to my son, Lewis Baker Warren," and "to the Anglo-Saxon race, to which the United States owes its culture, and as a means of maintaining the best ideals and traditions of that culture." The will provides that Yale University must accept the gift within six months

of the date of probate. Mrs. Lillian Baker Warren receives the income from the residue for life.

THE Elizabeth Clay Howald Scholarship has been endowed by the late Ferdinand Howald, an alumnus of the Ohio State University, in memory of his mother, Elizabeth Clay Howald. Appointments will be made annually and the scholar will receive an honorarium of $3,000 paid in twelve equal monthly installments. Any person who has shown marked ability in some field of study and has in progress work, the results of which promise to be an important contribution to our knowledge, shall be deemed eligible to appointment. If the scholar has ever been a student of the Ohio State University or a member of the university staff, he may carry on his investigation either at the Ohio State University or, subject to the approval of the Graduate Council, elsewhere. If the scholar has never had any connections with the Ohio State University, he must carry on his investigation there. Prospective candidates may secure application blanks, which must be filed not later than March 1, by addressing the Dean of the Graduate School, the Ohio State University. The appointment will be made on April 1 and the term of appointment will begin on July 1.

PROFESSOR MARSTON T. BOGERT writes: "Thanks to the generosity of interested friends, the Organic Laboratories of Columbia University have received recently research funds as follows: (1) From E. R. Squibb & Sons, 745 Fifth Avenue, New York, for investigations in the quinazoline series. (2) From the Ella Sachs Plotz Foundation, Collis P. Huntington Memorial Hospital, Boston, Mass., for researches on the synthesis of certain polycyclic hydrocarbons. (3) From the Committee on Therapeutic Research, of the Council on Pharmacy and Chemistry, American Medical Association, to assist in studies on the chemistry and pharmacology of the quinazoline group. With this support, work is actively under way in these fields, as well as in many others, and the results will be reported from time to time in our chemical periodicals."

DISCUSSION

THIRD SCARRITT EXPEDITION OF THE AMERICAN MUSEUM OF NATURAL HISTORY

THE activities of the first two Scarritt Expeditions, both to Patagonia, have previously been reported in this journal.[1] Twenty-seven papers (reference to which will be supplied on request to the writer) have been published on the Patagonian work. Most of the fossils collected on the second expedition have now been prepared, and their study is in progress, as is also the final report on the early mammalian faunas of South America.

The field work of the Third Scarritt Expedition, just completed, has continued the general program of these expeditions and of the American Museum of Natural History for research on early Tertiary, particularly Paleocene and Eocene, mammals of the world, this time in the Paleocene Fort Union Formation of the Crazy Mountain Field, Wheatland and Sweetgrass Counties, Montana. This work is due to the continued support and interest of Mr. H. S. Scarritt, of New York, with the cooperation of Mr. and Mrs. Fenley Hunter, of Flushing.

The party was in the field from June 4 to September 29, 1935, and consisted of the writer, Mr. A. C. Silberling, and a cook and helper for the full period. Mr. and Mrs. Hunter worked with the party during June, Dr. Walter Granger from August 8 to September 10, Mr. Albert Thomson from August 20 to the end and Mr. H. S. Scarritt from August 28 to August 31. Mr. F. Trubee Davison and party also visited the camp and made possible an aerial reconnaissance. Mr. Ray Wyn and numerous other local people cooperated in the most helpful way.

The success of this work is very largely due to Mr. Silberling, of Harlowton, Montana, well known for his work in this and other fields during the past thirty-five years. The localities worked were all discovered by him, and his knowledge and experience prevented lost motion and greatly facilitated all the work.

Forty-eight localities were thoroughly prospected, but the great bulk of the collections obtained is from two quarries. One, the Gidley Quarry, was discovered by Mr. Silberling, in 1908, and previously worked by him and by the late Dr. J. W. Gidley for the United States National Museum. Equally important is a new quarry, the Scarritt Quarry, recognized as a promising prospect by Mr. Silberling some years ago, but worked as a quarry this year for the first time.

The collection includes 635 jaws and partial skulls of mammals and about 900 isolated teeth, limb-bones and other less important specimens of fossil vertebrates. It is thus one of the largest extant collections of Paleocene mammals, and probably much the largest ever made in a single field season. The material has not yet been prepared or identified, but it apparently includes about 75 species of fossil mammals, a number of which appear to be new, and thus gives a remarkably complete picture of mammalian life in the Middle Paleocene.

Several different orders and many families of mammals are included, but greatest interest attaches to the Primates, which are the oldest known from anywhere

[1] SCIENCE, 80: 2070, 207–208, August 31, 1934.

in the world.[2] Preliminary descriptions of some of these from Mr. Silberling's previous collections were published in 1923 by Dr. Gidley. The new collection greatly adds to the known material, both in number and in variety, and also includes considerably better specimens than any previously discovered. It should prove of the greatest value for the study of the origin and early differentiation of the primates.

It is estimated that preparation and study of this collection will take at least three years. In the meantime work is going forward rapidly on the United States National Museum collection, a study started by Dr. Gidley and after his death placed in the hands of the present writer by the authorities of that institution. In order to prevent long delay and to ensure proper priority for earlier work, this study will be completed and published without waiting for the new collection to be available.

GEORGE GAYLORD SIMPSON
THE AMERICAN MUSEUM OF
NATURAL HISTORY

CASUALTIES AMONG ANIMALS ON MOUNTAIN ROADS

FROM time to time in the past few years there have been published lists of birds and mammals seen lying in the roads, killed by automobiles. These lists have been from the eastern and central states, and the majority of victims seem to have been birds. This past summer, 1935, I was in the mountains of Colorado from June 29 to July 25, and recorded such mammals and birds as were seen lying in the road.

My itinerary was as follows: From Colorado Springs through Canon City and Salida, across Monarch Pass down to Sargent and on to Gunnison. From Gunnison 12 miles north to Almont, and thence up Taylor River to Red Mountain Creek. Returning we went down Taylor River as far as the road across the Divide to East River at Jacks Cabin; thence north to Crested Butte. From this place we made trips to Gothic and Lake Brennan, at Irwin, and were about here until July 17. Then we returned to Gunnison, recrossed Monarch Pass to Salida, whence we went north as far as Chalk Creek, which stream we ascended as far as the old mining camp of Romley. From here we returned to the main road, went to Buena Vista and north to Half Moon Creek, which we ascended for several miles and where a few days were spent. Leaving here on July 25 we returned to Buena Vista, and thence went over Trout Creek Pass, and across South Park to Colorado Springs. Total mileage, 760.

I have purposely given this itinerary in considerable detail, though on some parts of the road no, or but very few, victims were seen.

To my companion, Robert C. Hill, of Denver, belongs the greater part of the credit for this list. He did all the driving and thus had to keep his eyes on the road, while my own eyes wandered far afield at times. The list follows:

Mammals: Cottontail rabbit, probably mostly *Sylvilagus nuttalli pinetis*, 8; white-tailed jack rabbit, *Lepus townsendi townsendi*, 4; Say's ground squirrel, *Callospermophilus lateralis lateralis*, 12; Gunnison's prairie dog, *Cynomys gunnisoni gunnisoni*, 56. Of these 29 were seen on July 1 along the 37 miles from Sargent to Gunnison, and 23 when returning from Gunnison to Sargent on July 17; wood rat, *Neotoma* sp., 1; mouse, sp. ??, 2; skunk, *Mephitis mesomelas varians*, 1; house cat, 1; total mammals, 85.

Birds: Magpie, 1; blackbird, sp. ?, 1; swallow, sp. ?, 2; robin, 1; hen, 1; unknown bird, 1; total birds, 7.

Reptiles: Garter snake, 3; rattlesnake, 1.

The great mortality among the prairie dogs along the Sargent-Gunnison stretch of road is explained by the fact that there are many of the animals there. It would seem that when a car comes along the prairie dog is usually on the opposite side of the road from its hole, and tries to get home ahead of the car. Sometimes it makes it, frequently it does not. Many of the dead prairie dogs seen were young animals.

EDWARD R. WARREN
COLORADO SPRINGS, COLO.

FORMATION NAMES IN THE MACKENZIE RIVER VALLEY[1]

THE pioneer map of the geology adjacent to the Mackenzie River by R. G. McConnell[2] was published in 1890. Thirty-one years later a report with two maps by E. M. Kindle and T. O. Bosworth[3] divided the Paleozoic sediments of the Norman-Good Hope area of the Mackenzie River into formations and indicated their areal distribution in the vicinity of the river.

It has been found that two names applied in this paper to previously undifferentiated formations were preoccupied by other formations. One of these names, Lone Mountain dolomite, was applied to an 1800 section of Silurian dolomite capped by Devonian limestone. The name, Lone Mountain limestone, had been previously used by Arnold Hague[4] for an Early Silurian formation[5] in the state of Nevada. Since there is no evidence that the Mackenzie River and the Nevada formations represent identical horizons, the

[1] Published with the permission of the Department of Mines, Canada.

[2] Report on an Exploration in the Yukon and Mackenzie basins, N.W.T. Ann. Rept. Geol. Surv. Can., Vol. VI, pp. 5D–163D (1890), 1888–89.

[3] Oil Bearing Rocks of Lower Mackenzie river valley. Summary Report, 1920, Pt.B., pp. 1B–72B, 1921.

[4] U. S. Geological Survey, 3d Annual Report, pp. 253, 262, 1883.

[5] *Bull. U. S. National Museum*, 92, p. 1516, 1915.

[2] Dr. G. L. Jepsen, of Princeton University, has recently discovered similar forms of approximately equal, but apparently not greater, age in Wyoming.

name North Nahanna River dolomite is here substituted for the Lone Mountain dolomite of Kindle and Bosworth. North Nahanna River enters the Mackenzie River adjacent to Lone Mountain, which was cited as the type locality for the formation, and the name is not preoccupied, according to the U. S. Geological Survey index of formation names.[6]

The topmost formation of the Devonian was given the name Bosworth sandstone and shale by Kindle and Bosworth from Bosworth Creek, which empties into the Mackenzie River at the oil well some forty odd miles below Norman.[7] This formation, with a thickness "probably exceeding 2,000 feet, though only the lower 1,000 feet have been found exposed," requires a new name, because Bosworth was used by C. D. Walcott for an Upper Cambrian formation in British Columbia.[8] The name Carcajou Mountain Beds is proposed in place of the name Bosworth. The new name is chosen from a mountain about 43 miles below Bosworth Creek.

On the south flank of the Wolverine anticline, which is responsible for Carcajou Mountain, a few hundred feet of these beds are to be seen along the bank of the Mackenzie River. A detailed section of the portion of this formation exposed here was given (p. 48B) when the formation was defined and may be regarded as representing nearly 500 feet of the type section.

E. M. KINDLE

GEOLOGICAL SURVEY
OTTAWA, CANADA

A CHEMICAL DIFFERENCE BETWEEN PROTEIN-LINKED AND FREE NUCLEIC ACID

A COMPARATIVE study has been carried out on the effect of phosphatase on thymonucleic acid and thymonucleohistone.

While free nucleic acid was nearly quantitatively dephosphorized within 24 hours in a monomolecular reaction, only about 20 per cent. of the phosphoric acid was released from the nucleohistone under the same conditions. The rest of the nucleohistone phosphorus was split off extremely slowly from the nucleohistone. This essential difference between the behavior of free nucleic acid and nucleohistone can not be caused by any inhibiting effect of the protein component upon the enzyme action, since in a mixture of nucleohistone and free nucleic acid the dephosphorylation of the latter is quantitative and proceeds at about the same rate as that of free nucleic acid alone.

It is very probable that the 20 per cent. of "hydrolyzable" phosphorus in the nucleohistone arises from the presence of free nucleic acid in the nucleohistone preparation, because the quantity of the easily released phosphorus is nearly proportional to the amount of the added nucleohistone and because the quantity of purine nucleosides, split off simultaneously with the phosphorus, corresponds exactly to the purine-phosphorus proportion in thymonucleic acid.

Concerning the nature of the chemical difference between free and histone-linked nucleic acid it is very improbable that this is caused by different structures of the two nucleic acids. Thus, there remains only the supposition that this difference is produced by the linkage of the nucleic acid component with the protein.

This theory is also supported by the fact that the resistance of the nucleoprotein against phosphatase disappears after digestion with pancreas extract. From such predigested nucleohistone, the phosphorus is split off quantitatively by nucleophosphatase at the same rate as from free nucleic acid.

The behavior reported here of thymonucleohistone is not a special property of this nucleoprotein, since a similar resistance against phosphatase was observed on spleen nucleoprotein.

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SCIENTIFIC BOOKS

ECONOMIC GEOGRAPHY

Fundamentals of Economic Geography. By NELS A. BENGTSON and WILLEM VAN ROYEN. xxviii and 763 pp.; maps, diagrams, illustrations, index. 9 by 6 inches. Prentice-Hall, New York, 1935.

THIS most recent of the several excellent college text-books in economic geography differs from others in the field in both organization and content. In departing from conventional organizations, the writers have performed the valuable service of calling attention to an effective plan for presenting the subject-matter of economic geography coherently. The inclusion of topics not generally considered as within the field of economic geography proper, presumably to supply the background which experience would indicate as lacking by the average college class, is not so fortunate, partially because it appears to assume too much inclusiveness for a limited aspect of geography and in part from the fact that it imposes a limitation on classroom use because of practical considerations which can not be ignored entirely in the selection of a text. Certainly some of the included material, such

[6] Letter from M. Grace Wilmarth, June 17, 1935.
[7] *Op. cit.*, p. 48.
[8] Nomenclature of some Cambrian Cordilleran formations: Smithsonian Miscellaneous Collections, 53: 1, p. 3, 1908.

as Chapter II dealing with the seasons, time and map projection, could have been omitted from a text in economic geography without serious loss.

In the opinion of the reviewer, the outstanding praiseworthy feature of the text is the organization of the treatment of agriculture on the basis of topical discussion of the production of climatically delimited regions rather than by political subdivisions or on a purely topical basis. This type of treatment, which might have been extended to other sections, has certain manifest advantages.

The style is simple and within the understanding of the students who will use the text; much of the material is presented in very interesting fashion; the illustrations, maps and graphs are both numerous and good; the text obviously fulfils adequately the objectives the authors had in mind in its preparation. The authors have both had years of successful experience, the results of which appear in this highly effective presentation of the field of economic geography in a new and attractively printed text due to meet merited approval.

Economic Geography. By R. H. WHITBECK and V. C. FINCH. Third edition. x and 550 pp.; maps, diagrams, illustrations, index. 9 by 5¾ inches. McGraw-Hill Book Company, New York, 1935.

IN the third and latest edition of this well and favorably known text in economic geography for beginning college students the subject-matter is organized on a "topical regional basis," as in the earlier editions, with political units as "regions" and with major emphasis on those areas of North America with English-speaking populations. Both the treatment of subject-matter employed and the greater importance of these areas to American students make this desirable, but there is no valid equivalent justification for the greater emphasis accorded to Latin America than to Asia.

Revision has involved but slight change in the text; even the pagination is essentially the same as in the first two editions: a flattering commentary on the earlier editions which have been tried and found satisfactory over a period of more than ten years. The most important difference between this edition and its predecessors is that outdated maps have been redrawn or graphs based on recent data have been substituted for maps which have outlived their usefulness for instructional purposes. These new maps and graphs measure up to the high standards of the text, though some are open to the criticism that there is no method of determining the date of the statistical material upon which they are based, *e.g.*, Fig. 8.

The first edition was a welcome addition to the list of college texts in economic geography; the third is a worthy successor to the first. Though there may be some slight differences of opinion as to the desirability of the organization of the subject-matter on a "topical regional basis" with political units as "regions," there should be general agreement that the authors have succeeded in writing a logically organized, readable, teachable and excellently illustrated text.

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FORESTRY

The Theory and Practice of Silviculture. By F. S. BAKER. 502 pp., 1934. McGraw-Hill Book Company, Inc., New York.

IF any proof be needed that forestry in this country is gradually emerging from empirical gropings and slavish imitations of European practice, Professor Baker's book gives ample evidence of it. Silviculture is nothing else than applied ecology and must rest upon plant physiology, soil physics and biology in general.

In western Europe, there are only about a half dozen commercial tree species, growing under a fairly uniform climate, with which the forester has to deal; forest practice has grown up there as a slow evolutionary process and has become, like agriculture, a part of the everyday life of the people. The scientific problems are therefore comparatively simple, and the scientific reasons for this or that practice are not very urgently needed.

In this country, where foresters have to deal with several hundred commercial species of trees, spread over a continent with a climate ranging from semi-tropical to arctic, from humid to arid, with an enormous variety of soil conditions, and a lack of historic and economic precedence in forest culture, forest practice must be built from the ground up—a practice suited to the needs of every locality and species. This requires ingenuity and freedom from any fixed European moulds, possible only when the scientific reasons for this or that step are clearly understood.

Professor Baker attempts, and in my opinion admirably succeeds, to combine in one volume both the different forest practices in the several forest regions of this country and the scientific background for such practices. He lays the scientific foundation for an indigenous silviculture, and shows that forest management can succeed only when it is firmly grounded in natural sciences. Although the book is divided into five chapters, it really falls, on the basis of the topics treated, roughly into two almost equal parts. Of the 459 pages of the text proper, some 264 pages are devoted to plant physiology, soils and ecology, as they apply to the life of the forest, and the remainder to the discussion of the different silvicultural systems.

In a book of such scope, one may find, according

to his own personal interest or particular hobby, some topics treated too briefly, while others at greater length than they would seem to deserve. For instance, too much emphasis, it seems to me, has been laid on soil nitrification—a process which, under our climatic conditions, is not very important because of the small amount of raw humus prevalent in our soils. A discussion of a soil classification, as it is related to forests, mechanical and structural composition of the soil, and its flora and fauna, would be more serviceable in explaining the success or failure of forest plantations, and the differences in composition and growth of forest stands, than the nitrogen and mineral cycles of the soil. However, a writer of a text-book is necessarily limited by the state of knowledge in the different fields, and soil nitrification in the past has received greater attention than other soil relationships.

On the whole, the book is an outstanding contribution to our too scanty scientific forestry literature. Its thorough scientific and analytical approach to the present-day practices, its lucid style and its interesting method of presentation make it stimulating and readable. It should, therefore, be of distinct service in the classroom and helpful to the practicing forester who is confronted with silvicultural problems for which there is no empirical knowledge.

RAPHAEL ZON

U. S. FOREST SERVICE

SPECIAL ARTICLES

DIFFERENTIATION OF THE ANTI-DERMATITIS FACTOR[1]

WE demonstrated some time ago that if vitamin B carriers are exposed to ultra-violet irradiation at least one member of the vitamin B complex is destroyed, and all rats that receive the irradiated preparations sufficiently long develop a severe dermatitis and succumb. The basal diet, No. 1669, is made up of casein 20, sucrose 71, salts 4, cod liver oil 2, cellulose 3, and presumably is deficient in all members of the vitamin B complex. The vitamin B carrier is a water extract of yeast, which is submitted to intense irradiation for a period of 10 hours. This is supplied separately in doses of 50 mg dry matter daily.

It soon became evident that the destructive action of ultra-violet irradiation can not be demonstrated if the experimental diet contains any considerable amount of corn-starch. Since it was unlikely that the dermatitis was healed or prevented by starch itself, it seemed probable that the active agent was a contaminant, and so the starch was extracted with alcohol. The extracted starch was found to be inactive, so the extract was concentrated and supplied to animals which had pronounced lesions. When supplied in daily doses of 100 mg healing followed promptly, so other oils were investigated also. Wheat-germ oil has approximately the same activity. Mazola and linseed oil were less effective, and cocoanut oil was almost entirely ineffective.

The fact that the alcohol extract of corn-starch prevents this type of dermatitis supports an earlier suggestion[2] that the preventive agent is not identical with vitamin G, as that term is commonly understood, and an attempt was made to establish this fact more definitely. It had been observed two years ago that dermatitis was healed by tikitiki, but the animals grew slowly and in 12 to 16 weeks they developed extensive denuded areas. It was also observed, as would be expected, that if the young rats are given tikitiki at the beginning of the experimental period as the sole source of the vitamin B complex they become denuded in the same way in about the same length of time. This condition is apparently identical with that described by Sherman and Sandels,[3] but, however that may be, the symptoms have at most only a superficial resemblance to our type of dermatitis. It was decided therefore to produce the two types of symptoms more or less simultaneously and to study their response to various curative agents.

A number of rats were denuded by the procedure described above, and then supplied with 100 mg of wheat-germ oil daily, but this supplement had not the slightest observable effect. The animals declined steadily and died in about the same time as the controls. In the meantime it had been announced that flavines are identical with vitamin G, so their[4] curative properties were investigated. Five of the denuded animals, in addition to the tikitiki, were given daily one drop, 1.0 mg organic matter, of the flavine preparation. They began growing rapidly, and in 2 weeks the denuded areas were completely covered with a new growth of fur. The animals were entirely normal in appearance, but insufficient time has elapsed to deter-

[1] Contribution from the Missouri Agricultural Experiment Station Journal Series No. 412. From the Departments of Animal Husbandry and Agricultural Chemistry, University of Missouri.

[2] A. G. Hogan and L. R. Richardson, *Jour. Nutrition*, 8: 385, 1934.

[3] H. C. Sherman and M. R. Sandels, *Jour. Nutrition*, 3: 395, 1931.

[4] We are greatly indebted to Dr. J. F. Stare, of Washington University, who supplied the material used in establishing the nutritional properties of flavines. More recently lacto-flavine prepared by Dr. Richardson has been found equally effective. See R. Kuhn, P. Gyorgy and Th. Wagner-Jauregg, *Ber.*, 66: 1037, 1933.

mine whether they can reach, and maintain, normal mature weights on this combination.

Rats suffering from dermatitis were also supplied with the flavine preparations, but these did not retard the course of the disease in the slightest degree. As mentioned previously, wheat-germ oil heals the dermatitis. The animals gained slowly for several weeks and then declined, with no recurrences of dermatitis. These animals did not become denuded, an anomaly that is hard to explain. If, in addition to the oil, these animals are also given 1 drop daily of the flavine preparation they gain in weight and assume a normal appearance. It is too early as yet to determine whether they can reach mature weight, or whether the maximum weight can be sustained. Additional details are supplied in Fig. 1.

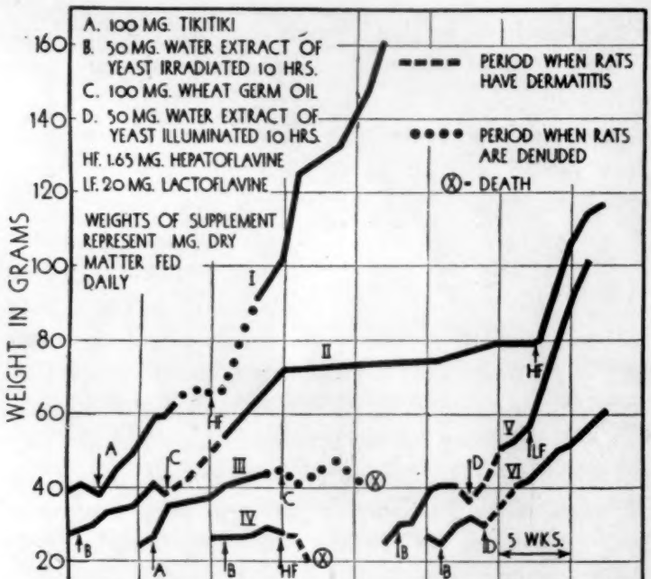

FIG. 1. I. Rats become denuded on tikitiki, and are healed by flavines. II. Dermatitis is healed by wheat germ oil, but growth does not occur unless flavines are added also. III. Wheat germ oil has no effect on denuding. IV. Flavines have no effect on dermatitis. V and VI. Illuminated vitamin B carriers heal dermatitis, but flavines in addition must be added to support normal growth.

Evidently the two conditions have little or no relation to each other. Wheat-germ oil heals dermatitis but does not relieve the denuded condition. Flavine heals the denuded condition but does not relieve the dermatitis. These facts show clearly that ultra-violet irradiation destroys at least two vitamins, the flavine, and the anti-dermatitis factor which has not been identified as yet. It is possible that still others are destroyed also.

It has been reported previously[5] that the anti-dermatitis factor is not destroyed by irradiation if the ultra-violet portion of the spectrum is excluded. Since flavines are labile to the visible spectrum, additional observations on this point seemed desirable. Six rats were each supplied with 50 mg daily of the water extract of yeast that had been illuminated through plate glass for 10 hours at a distance of 10 inches with a 1,500 watt Mazda bulb. They made only slight gains in weight, but there was not a single well-defined case of dermatitis. The controls received 50 mg of the yeast extract that had been subjected to ultra-violet irradiation, and they developed dermatitis and died in the usual time. Ten other rats received the irradiated preparation until they developed definite cases of dermatitis; then they were changed to the preparation which had been illuminated with the Mazda bulb, as described above. Every animal recovered from dermatitis, but the gains in weight were slight. When the illuminated material was fortified with 1 drop daily of the flavine preparation growth was resumed, but it is too early to decide whether this combination is complete in every respect. Some additional details are shown in Fig. 1.

ALBERT G. HOGAN
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WHY HAVE SOME INVESTIGATORS BEEN UNABLE TO GROW CHILOMONAS PARAMECIUM IN INORGANIC OR SIMPLE ORGANIC SOLUTIONS?

PRINGSHEIM[1] maintains that *Chilomonas paramecium* will grow in sterile inorganic solutions containing glycocoll and acetate, but not if the nitrogen and carbon containing compounds are less complex. Mast and Pace[2] conclude that it will grow if these two elements are in the form of inorganic or simple organic compounds, *i.e.*, they maintain that it can obtain nitrogen from ammonium salts and carbon either from acetates, formates or carbon dioxide. Pringsheim[3] was unable to confirm these conclusions concerning the utilization of CO_2; and Loefer[4] was unable to confirm the conclusions concerning the utilization of CO_2 or acetates. He says: "It was impossible to maintain bacteria-free cultures of *Chilomonas paramecium*—in a medium containing inorganic nitrogen, even in the presence of sodium acetate as a carbon source." Loefer and Hall[5] repeated the experiments of Loefer, using some of the media of Mast and Pace and their technique as well as that developed by

[5] A. G. Hogan and L. R. Richardson, *Jour. Nutrition*, 8: 385, 1934.

[1] E. G. Pringsheim, *Beitr. z. allg. Bot.*, Bd. 2, S. 88–137, 1921.

[2] S. O. Mast and D. M. Pace, *Amer. Jour. Physiol.*, 101: 75, 1932; *Anat. Rec.*, 54: 101–102, 1932; *Protoplasma*, 20: 326–358, 1933.

[3] E. G. Pringsheim, *Naturwiss., Bd.* 23, S. 110–114, 1935.

[4] J. B. Loefer, *Biol. Bull.*, 66: 1–6, 1934.

[5] J. B. Loefer and R. P. Hall, SCIENCE, 81: 486, 1935.

Loefer, but they obtained growth for only a few days. They conclude: "It would seem, therefore, that our strain of *Chilomonas paramecium* is unable to synthesize protoplasm from ammonium compounds and other inorganic salts and is thus quite different in this respect from the strain used by Mast and Pace." Loefer[6] concludes that their strain can not even "utilize as a source of nitrogen any of the single amino-acids tested," *i.e.*, "glycine, dl-valine, l-leucine, dl-leucine, dl-iso-valine, dl-β-phenylalanine, l-tyrosine and the compound asparagin."

At our request Loefer and Hall very generously sent us a sample of their strain of *Chilomonas*. This sample contained bacteria when it arrived, having, unfortunately, been contaminated en route. Loefer and Hall had for two or three years grown their strain in a bacteria-free solution containing tryptone.

We added to this solution an equal quantity of our solution D, *i.e.*, a solution containing nitrogen in the form of ammonium chloride and carbon in the form of acetate and left it 12 hours; then several specimens were removed with .1 cc of the solution and added to .3 cc of solution D and left 12 hours, after which single individuals were removed, passed through several portions of fresh solution D and cultured on depression slides in accord with the method described by us.[7]

Four lines of isolation cultures were thus established and carried for six weeks with daily transfers. During this time the average rate of fission was 3.06 per day, *i.e.*, it was practically the same as that obtained in our earlier experiments with our strain of *Chilomonas*. None of the lines died out during the experiment and at the close the specimens in all were in excellent condition and indistinguishable from those in our strain cultured in solution D. There is therefore no reason for assuming that the two strains in question differ. We have grown in the acetate-ammonium solution chilomonads collected at Woods Hole, Mass., Baltimore, Md., Durham, N. C., and Birmingham, Ala. It is therefore not probable that there are different strains of *Chilomonas* in reference to ability to obtain nitrogen and carbon from simple compounds.

We have repeatedly observed that if chilomonads are transferred from a glucose-peptone solution directly to an acetate-ammonium solution or from this solution directly to this solution minus acetate nearly all die immediately, and that those which do not die immediately divide infrequently and usually die after a few days. We have also repeatedly observed that if the concentration of the acetate is too low there is frequent division for a few days during which the chilomonads become smaller and smaller until they die. The failure of Loefer[8] and Loefer and Hall[9] to obtain growth in our inorganic solution (solution I) or our acetate-ammonium solution (solution D), and Loefer[10] to obtain growth in solutions containing but one amino-acid was therefore probably due to insufficient care in transferring the chilomonads from their tryptone solution to the solutions containing ammonium chloride and acetate or a single amino-acid, or to unsatisfactory concentrations of acetate.

Pringsheim presents no details concerning the methods used in his attempt to grow *Chilomonas* in inorganic solutions. We are therefore unable to offer any suggestions concerning the cause of his failure.

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D. M. PACE

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[6] J. B. Loefer, *Arch. f. Protist.*, *Bd.* 85, S. 74–86, 1935.
[7] *Protoplasma*, 20: 326–358, 1933.
[8] *Biol. Bull.*, 66: 1–6, 1934.
[9] SCIENCE, 81: 486, 1935.
[10] *Arch. f. Protist.*, Bd. 85, S. 74–86, 1935.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

PARADICHLOROBENZENE AS A HERBARIUM INSECTICIDE

THE author read with interest an article recently published in this journal entitled, "Paradichlorobenzene, an Effective Herbarium Insecticide."[1] The gratifying results obtained by the author of this article are similar to the results experienced by many of us who have been using this herbarium insecticide for the past several years. The use of paradichlorobenzene in herbariums goes back several years. It was used in a part of the National Herbarium prior to 1930, and also in many other herbariums prior to that date. The use of this insecticide has become so popular that the old method of periodic fumigation with hydrogen cyanide or carbon bisulfide is almost obsolete.

Even though good results were obtained by the author of the above-mentioned article by placing the crystals of paradichlorobenzene on the *bottom* of the herbarium cases, it is considered to be better practice to place the crystals on the *top* shelves of the cases. The fumes of the insecticide are heavier than air, and thus by placing the crystals near the top better distribution of the insecticidal gas is obtained. When the crystals are placed at the bottom, distribution of the heavier-than-air gas depends upon convection currents.

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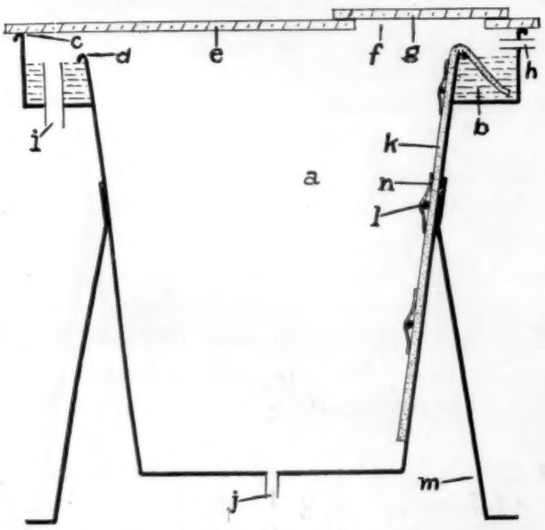
[1] Frank C. Gates, SCIENCE, 81: 438, 1935.

A GERMINATOR FOR ROOT WORK

THE germinator illustrated schematically in the accompanying figure has been developed for obtaining germinated seeds with straight roots for use in testing the effects of environmental conditions on elongation of the young radicle (by the Macht-Livingston technique[1]) and in starting seedlings intended to be grown in solution-culture or by a sheet-culture technique shortly to be described. It incorporates a feature found in the Vogt germinator[2] of the absorbent stratum on which the seeds rest, being kept moist by capillarity in a downwards direction, but differs from it in the nearly vertical position of the absorbent stratum, and in this stratum being on the inner face of a cylindrical (or, more correctly, frusto-conical) surface.

The general plan of construction of the germinator is that of an oversized bucket (the moist chamber, *a* in the accompanying figure) with an annular water



trough (*b*) built onto its rim, on the outside. The outer rim (*c*) of this annular trough is decidedly higher than its inner rim (*d*), so that there is a clear space between the inner rim (*d*) and a circular sheet of glass (*e*) resting on the outer rim (*c*) and serving as a removable transparent cover for the germinator. In this glass cover is a circular opening (*f*) six inches in diameter, placed so that it comes above the outer edge of the moist chamber and somewhat over the water trough. Through this opening it is readily possible to add water, for instance, to the water trough, or to insert a hand and carry on manipulations (such as the withdrawal of germinated seeds) in the moist chamber, with a minimum disturbance of the humid condition of the air in the chamber. An eight-inch circle of glass (*g*) resting on the main sheet of glass serves to close this opening when not in use. An opaque metal cover (not shown) rests on the glass cover and serves to exclude light from the germination chamber. An inflow tube (*h*) and an overflow tube (*i*) make it possible to maintain the water level in the trough by continuous water flow. The tube (*j*) in the bottom of the moist chamber serves to carry away the drip water from the absorbent paper strips (*k*) on which the germinating seeds (*l*) rest. (*m*) indicates the supporting legs of the germinator.

As has been indicated, the seeds (*l*) are germinated on strips of absorbent paper (*k*), the upper ends of which dip into the water in the annular water trough. Small seeds, such as mustard and cabbage, are readily held onto the paper simply by the force of cohesion of the water film on the surface of the wet seed with the water of the wet paper; but for additional protection a small piece of wet absorbent tissue paper (*n*) is dropped over the seed. Larger seeds, such as green pea and corn, are attached by wrapping a piece of absorbent tissue paper around the seed and the paper strip.

As compared with the germination of seeds in moist sawdust or ground sphagnum or sand, the method described here has the obvious advantages of the young root developing in water-saturated air under conditions of minimum disturbance by mechanical contacts, as well as of the germinating seed being available at all times for inspection without being subjected to mechanical disturbance. An additional and decided advantage is that the germinated seed is readily manipulated (as, in the Macht-Livingston technique, introduced into solutions to be tested) by means of the absorbent paper strip to which it is attached. Further, if, at the beginning of the test, the strip of paper bearing the germinated seed is cut at the length of the young radicle, then the extension of the root beyond the cut end of the strip at the close of the test period is a measure of its elongation during that period.

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[1] *Jour. Gen. Physiol.*, 4: 573–584, 1922.
[2] German patent 20,070, November 20, 1882.

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